

## CLAIMS

1. A method of calibrating a colour monitoring system so as to compensate for non-ideal real camera characteristics,  
5 the method comprising:

establishing a camera offset by measuring or calculating the output voltage of the camera when substantially no light falls on any of its sensor elements,  
10 hereinafter referred to as establishing the offset;

establishing the point at which a graph of input light intensity against camera output voltage starts to deviate from a substantially linear characteristic, hereinafter  
15 referred to as establishing the knee; and

restricting the amount of light incident on all sensor elements of the camera such that the maximum output corresponds to a voltage at, or below, the knee, and lower  
20 light intensities are all within the range of linear operation.

2. The method according to claim 1, wherein the step of establishing of camera offset is carried out on a  
25 periodical basis to keep pace with the variations in offset value caused by variation in ambient conditions.

3. The method of claim 1 or 2, wherein the step of establishing offset is carried out whenever an image  
30 capture operation for capturing a desired image to be monitored is to be carried out.

4. The method of claim 1, 2 or 3, wherein setting the point of zero light intensity is achieved by closing the camera iris.

5 5. The method of claim 1, 2 or 3, wherein setting the point of zero light intensity is achieved by setting the camera to monitor a black image, or a black part of an image field of the camera.

10 6. The method of claims 1, 2 or 3, wherein setting the point of zero light intensity is achieved by extrapolating from measurements obtained from two or more points of known reflectance somewhere in an image field of the camera.

15 7. The method of claim 6, wherein one point of known reflectance comprises an integral part of the desired image itself.

20 8. The method of claim 6 or 7, wherein one point of known reflectance comprises a white reference tile within the image field.

25 9. The method of any of the preceding claims, wherein there is provided a source of maximum light reflectance within the image field by ensuring that a white object is present somewhere in the image field.

30 10. The method of any of the preceding claims, wherein restricting the camera to operate within the linear region is achieved by reducing the camera aperture by closing the iris to a predetermined degree such that the output voltage when measuring the source of maximum light intensity

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corresponds to a camera output voltage at or below the knee.

11. The method according to claim 10, wherein the iris is  
5 restricted so as to give an appropriate camera output voltage which is a proportion of a full scale value.

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10 12. The method of claim 10 or 11, wherein restriction of the iris is arranged to ensure that a perfect white reflector registers at the top of the linear region and to then scale down to find appropriate values of camera output versus light intensity.

13. The method of any preceding claim, wherein the step of  
15 establishing the knee is carried out less frequently than the step of establishing the offset.

14. The method of claim 13, wherein the step of  
20 establishing the knee is carried out before commencing a plurality of print runs each comprising a plurality of image capture operations.

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25 15. The method of claim 13 or 14, wherein the step of establishing the knee is carried out after completing a plurality of print runs each comprising a plurality of image capture operations.

16. A method of compensating for non-uniformity of lighting  
30 across a camera field of view when performing an image capture operation to be monitored by the camera, the method comprising:

positioning substantially uncoloured or uniformly surface coloured material of known colour characteristics in a field of view of the camera; and

5 capturing image data from the camera and storing such captured image data as a "uniformity image" the image data of the uniformity image including information concerning the degree of light reflected from or transmitted by the different spatial areas of the material detected by the  
10 camera.

17. The method of claim 16, wherein image capture operations of images to be inspected are thereafter carried out and compensation for non-uniform lighting conditions  
15 effected for each captured image.

18. The method of claim 17, wherein the compensation comprises normalising each newly captured image across the camera field of view by determining spatial adjustment  
20 factors from the uniformity image and, where no uniformity image data is available for a particular spatial location, interpolating between the various positions or extrapolating beyond them.

25 19. The method of claim 18, wherein the step of normalising each newly captured image comprises the sub-steps of: recording output data from the camera averaged over all the pixels in a given spatial area of the sample with the sample at a first, training, position on a printed web to  
30 be captured by the camera to give first position camera channel output data  $C_1$ ; and recording the camera output data from the camera averaged over all the pixels in the same given spatial area of the sample with the sample at a

second position on the printed web having different lighting conditions to give second position camera channel output data  $C_s$ .

- 5 20. The method of claim 19, wherein the step of normalizing further comprises normalizing the second position camera channel output data  $C_s$  prior to comparing them to the trained values from the first position camera channel output data  $C_T$  by processing them in accordance with the  
10 following equation:  $C_s \times C_1/C_2$ , where  $C_1$  is the average channel value for the area of an unprinted web captured by the camera during the image capture operation and corresponding to the first position, and  $C_2$  is the average channel value for the unprinted web corresponding to the  
15 second, differently lighted position.

21. The method of claim 20, wherein three camera channels R, G and B (red, green, blue) are present.

- 20 22. The method of claim 21, wherein for the red channel R, the first position camera channel output data is  $R_T$ , the second position camera channel output data is  $R_s$ , the average red value for the area of an unprinted web corresponding to the starting position is  $R_1$  and the  
25 average value of an unprinted web corresponding to the second, differently lighted, position is  $R_2$ .

23. A method for the capture and analysis of image data of a moving material monitored by a camera having its field of  
30 view trained on the material, the method comprising:

storing a pattern recognition model comprising image data corresponding to at least part of a pattern repeat printed on the monitored material;

5       measuring the displacement of the pattern model in each captured image of the printed web relative to a captured training image to sub-pixel accuracy; and

calculating the colour of the displaced vignette or  
10   half-tone area allowing for sub-pixel displacements (both vertical and horizontal).

24. A method according to claim 23, wherein subsequent to the step of measuring the displacement and prior to the  
15   step of calculating the colour, there are performed the following steps:

on the basis of the measured displacement, calculating a displacement value by which a camera used to capture  
20   images of the web is to be moved in a transverse direction relative to the web so as to substantially reduce transverse displacement of the pattern recognition model relative to the captured training image during a subsequent image capture operation; and

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moving said camera according to the calculated displacement value; and

carrying out said subsequent image capture operation.

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25. A method according to claim 24, wherein following said step of carrying out said subsequent image capture operation there is then carried out a further step

comprising measuring the displacement of the pattern model in a the newly captured image of the printed web to sub-pixel accuracy.

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5 26. A method according to claim 24 or 25, wherein  
displacements of the pattern model in the longitudinal  
direction of the web are compensated for by delaying or  
speeding up a trigger signal fed to the camera, so as to  
perform an image capture operation relatively earlier or  
10 later according to a measured longitudinal displacement of  
the pattern recognition model relative to the captured  
training image.

27. The method of claim 23, 24, or 25, wherein the method  
15 further includes the steps of:

monitoring synchronization signals (SYNC) from the  
camera; and

20 in accordance with the operating characteristics of the  
camera, triggering a lighting source during the camera  
vertical blanking interval so as to illuminate the material  
during image capture periods.

25 28. The method of any of claims 23 to 25 and 27, wherein  
image capture is arranged to take place at time intervals  
which can be externally monitored by means of monitoring  
camera output SYNC signals and illumination of the web is  
provided at the appropriate moment around image capture and  
30 is triggered by the SYNC signals.

29. The method of any of claims 23 to 28 wherein image data  
from the camera is analyzed so as to carry out a pattern

recognition operation based upon the pattern recognition model to determine the physical position of the printed pattern repeat on the web in the field of view of the camera at the time of image capture.

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30. The method of claim 29, wherein following successful pattern recognition, analysis of the image captured to inspect the required areas displaced by the same displacements as the pattern model is carried out with sub-pixel accuracy.

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